August 2009
IYA Discovery Guide

This Month's Theme:

Rocks and Ice in the Solar System

Featured Activity:

Cook Up a Comet

Featured Observing Object:

Perseid Meteor Shower

The International Year of Astronomy is a global celebration of astronomy and its contributions to society and culture, highlighted by the 400th anniversary of the first use of an astronomical telescope by Galileo Galilei.
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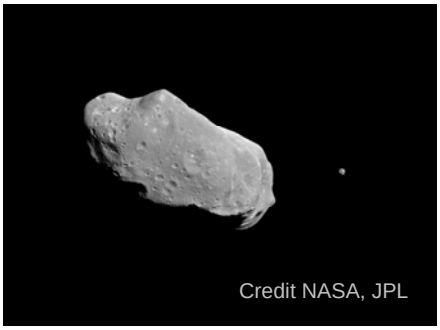
http://www.astrosociety.org

August's Topic:
Rocks and Ice in the Solar System


Credit NASA, JPL

Our Solar System consists of the Sun, planets, and moons, but it also contains a multitude of smaller chunks of rock and ice. These objects were left over from the time when our Sun and Solar System formed.

So where are all of these small neighbors? Millions of rocky chunks called asteroids orbit in a region between the four rocky inner planets and the four outer gas giant planets. The Dawn mission is currently on its way to investigate Ceres and Vesta, two of the largest asteroids. Beyond Neptune, there is another swarm of objects made mostly of ice and dust. This is the disc-shaped region known as the Kuiper Belt, the origin of many comets. Some comets originate even farther out, from a giant shell of objects near the edge of the Solar System known as the Oort Cloud.


Credit NASA, GSFC

In Galileo's time, comets were the topic of hot debate. It was unclear whether they occurred in Earth's atmosphere (between us and the Moon) or out in the realm of the planets or stars. Today, we understand that icy chunks from the Kuiper Belt occasionally get knocked out of their orbits by passing stars or gravity changes in the Milky Way. When their new trajectories take them near the Sun and they heat up, we see the ice begin to sublimate (turn directly from a solid to a gas) and that gives them their bright head and long tail.

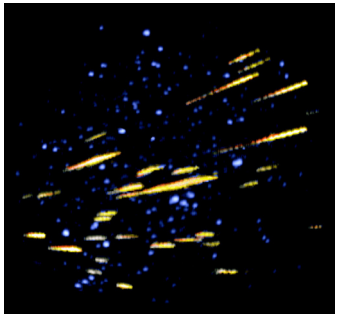
As the ice disappears, some of the rocks and dust trapped in the comet crumble off, leaving a trail of small particles. When the Earth is lucky enough to pass through one of these trails, we get a beautiful meteor shower! What some people call "shooting stars" are actually just pieces of asteroids or comets — most are smaller than golf balls — falling into Earth's atmosphere, burning up and making a bright streak across the sky. Occasionally, meteorites even come to Earth from other planets such as Mars. You don't need a telescope to view meteors; just watching the dark sky is the best way to see them. This month, keep an eye out for the Perseid Meteor shower made by Comet Swift-Tuttle. It will peak early in the morning on August 12th.

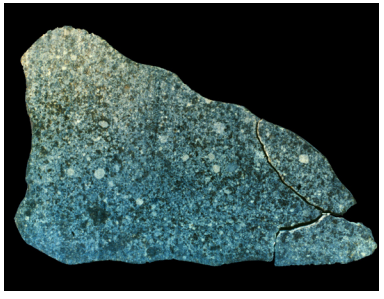
Scientists at NASA are studying these small objects throughout our Solar System. NASA's Astromaterials Curation Office houses and analyzes meteorites and samples returned from space missions. In 2005, the spacecraft Deep Impact sent an impactor into the nucleus of comet Tempel 1 and collected data about some of the ejected core material. The Hubble Space Telescope captured some wonderful images of a string of comet pieces hitting Jupiter in 1994. NASA's Stardust mission even collected cometary particles and returned a sample to Earth. NASA studies comets because they may yield important clues about the formation of the Solar System. You can find out what they are made of by cooking up a comet in the attached activity!

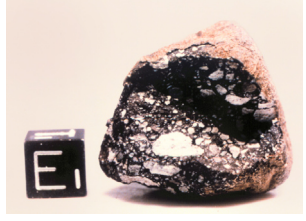
Learn more about Rocks and Ice in the Solar System from NASA.
Find more activities featured during IYA 2009.
See what else is planned for the International Year of Astronomy.

National Aeronautics and Space Administration
www.nasa.gov

Meteors and Meteorites







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Meteors and Meteorites

"Shooting stars," or meteors, are bits of interplanetary material falling through Earth's atmosphere and heated to incandescence by friction. These objects are called meteoroids as they are hurtling through space, becoming meteors for the few seconds they streak across the sky and create glowing trails. Chunks of these extraterrestrial visitors that survive their journey through the atmosphere and fall to the ground are called meteorites.

Several meteors per hour can usually be seen on any given night. Sometimes the number increases dramatically — these events are termed meteor showers. Some occur annually or at regular intervals as the Earth passes through the trail of dusty debris left by a comet. Meteor showers are usually named after a star or constellation that is close to where the meteors appear in the sky. Perhaps the most famous are the Perseids, which peak around August 12 every year. Every Perseid meteor is a tiny piece of the comet Swift–Tuttle, which swings by the Sun every 135 years. Other meteor showers and their associated comets are the Leonids (Tempel–Tuttle), the Aquarids and Orionids (Halley), and the Taurids (Encke). Comet dust in meteor showers burns up in the atmosphere before reaching the ground.

Most meteorites are no bigger than an average Earth rock, but some have been quite large, especially in Earth's early history. Large meteorites can cause extensive destruction when they strike. One of the most distinct impact craters is the Barringer Meteor Crater in Arizona, about 1,000 meters (3,300 feet) across. It is only 50,000 years old and so well preserved that it has been used to study impact processes. Since this feature was recognized as an impact crater in the 1920s, about 160 impact craters have been identified on Earth. A very large asteroid impact 65 million years ago, which created the 300-kilometer (180-mile) wide Chicxulub crater on the Yucatán Peninsula, is thought to have contributed to the extinction of about 75 percent of marine and land animals on Earth at the time, including the dinosaurs. Well-documented stories of meteorite-caused injury or death are rare, but in November 1954, Ann Hodges of Sylacauga, Alabama, was severely bruised by a 3.6-kilogram (8-pound) stony meteorite that crashed through her roof.

Meteorites may resemble Earth rocks, but they usually have a "burned" exterior. This fusion crust is formed as the meteorite is melted by friction as it passed through the atmosphere. There are three major types of meteorites: the "irons," the "stones," and the "stony-irons." Although the majority of meteorites that fall to Earth are stony, more of the meteorites that are discovered long after they fall are "irons" — these heavy objects are easier to distinguish from Earth rocks than stony meteorites. Meteorites also fall on other planets. Imagine the excitement when Mars Exploration Rover Opportunity found an iron meteorite on Mars!

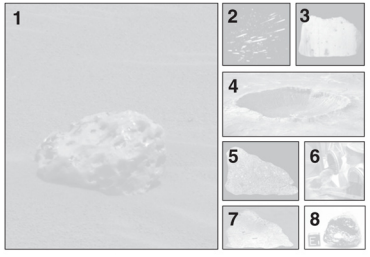
More than 30,000 meteorites have been found on Earth. Of these, 99.8 percent are thought to come from asteroids. Evidence for an asteroid origin includes: orbits calculated from photographic observations of meteorite falls project back to the asteroid belt; spectra of several classes of meteorites match those of some asteroid classes; and all but the rare lunar and martian meteorites are very old, 4.5 to 4.6 billion years. However, we can only match one group of meteorites to a specific asteroid. The eucrite, diogenite, and howardite igneous meteorites come from the third largest asteroid, Vesta. Asteroids and the meteorites that fall to Earth are not pieces of a planet that broke apart, but instead the original diverse materials from which the planets formed. The study of meteorites tells us much about the conditions and processes during the formation and earliest history of the solar system.

The remaining 0.2 percent of meteorites is split roughly equally between meteorites from the Moon and Mars. The current 35 known martian meteorites were blasted off Mars by meteoroid impacts. All are igneous rocks crystallized from magma, with distinctive composition indicating martian origin. Controversy continues about whether structures found in the meteorite known as ALH84001 might be evidence of fossil martian bacteria. The 36 lunar meteorites are similar in mineralogy and composition to Apollo Moon rocks, but distinct enough to show that they have come from other parts of the Moon. Studies of lunar and martian meteorites complement studies of Apollo Moon rocks and the robotic exploration of Mars.

SIGNIFICANT DATES

4.55 billion years ago — Formation age of most meteorites, taken to be the age of the solar system.
65 million years ago — Chicxulub impact that leads to the death of dinosaurs and 75 percent of animals on Earth.
50,000 years — Age of Barringer Meteor Crater in Arizona.
1478 BC — First recorded observation of meteors.
1794 AD — Ernst Friedrick Chladni publishes the first book on meteorites.
1908 (Tunguska), 1947 (Sikote Alin), 1969 (Allende and Murchison), 1976 (Jilin) — Important 20th-century meteorite falls.
1969 — Discovery of meteorites in a small area of Antarctica leads to annual expeditions by U.S. and Japanese teams.
1982–1983 — Meteorites from the Moon and Mars are identified in Antarctic collections.
1996 — A team of NASA scientists suggests that martian meteorite ALH 84001 may contain evidence of microfossils from Mars.
2005 — NASA's Mars Exploration Rover Opportunity finds an iron meteorite on Mars.

ABOUT THE IMAGES



1 A basketball-size iron meteorite found on Mars by Opportunity rover.

2 A burst of meteors photographed by NASA Ames Research Center scientists in 1995.

3 The glassy black patches in this martian meteorite contain atmospheric gases.

4 Barringer Meteor Crater in Arizona.

5 A stony meteorite found in Antarctica.

6 A scientist working in the Meteorite Processing Lab at NASA Johnson Space Center.

7 An iron meteorite from Barringer Meteor Crater.

8 A lunar meteorite found in Antarctica similar in composition to lunar rocks brought back by Apollo astronauts.

FOR MORE INFORMATION

solarsystem.nasa.gov/planets/profilecfm?Object=Meteoroids

LG-2005-12-571-HQ — JPL 400-1253J 12/05

August 2009 Featured Observing Object:

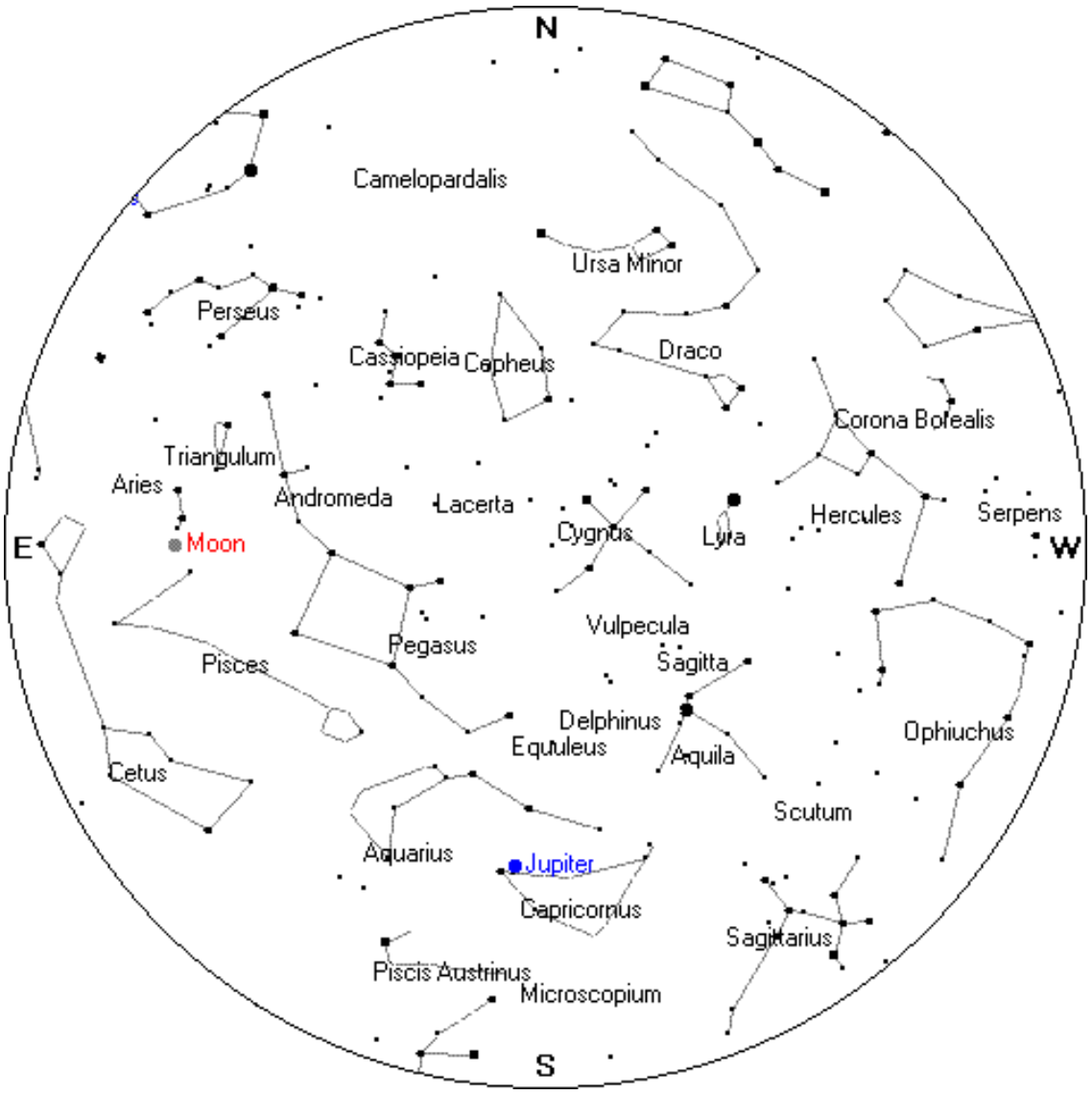
Perseids Meteor Shower Finder Chart

For information about meteor showers: http://solarsystem.nasa.gov/planets/profile.cfm?Object=Meteors

To view: unaided eyes

If you stay up past midnight on August 11 this year, you will have the best chance of viewing the Perseid Meteor Shower. Meteors are bits of rock and dust often left behind by comets that passed through the orbit of the Earth. When these tiny bits hit our atmosphere, they burn up, leaving bright trails to delight us. These are not "shooting stars" after all! Lie on your back with the top of your head pointing north and hold this map up towards the sky to discover the constellations while you watch for meteors.

View of sky from about 35 degrees N latitude (Los Angeles, California) at 1:00 AM on 12 August 2009.



Cook Up a Comet

Learn About Comets By Making One

About the Activity

The Cook Up a Comet activity gives insight into the "dirty snowball" model of comets- composed of material from the early solar system in the form of frozen water and gases, simple organic compounds, and dust. Using dry ice and simple household materials, this comet concoction is a big hit with kids and adults alike.

Topics Covered

- What a comet is made of
- How the Solar System formed

Participants

This activity can be done as a demonstration with families, the general public, and school groups ages 9 and up. To have school groups make their own comet, it is recommended that each group have adult supervision. See more tips on leading this as a group activity, see the Helpful Hints.

Materials Needed

- Measuring cup
- Large spoon
- Mixing bowl
- 4 black garbage bags
- Hammer (use one for many comets)
- Work gloves and protective goggles
- Dry Ice – 2 cups per comet
- To find dry ice in your area: http://www.dryiceinfo.com/
- Ammonia (window cleaner) – 2 Tbs.
- Dark corn syrup (or cola) – 1 Tbs.
- Water – 2 cups
- Dirt - 1/4-cup
- *(Optional)* Overhead projector and glass bowl or a heat lamp to show comet tail

Adapted with permission from Dennis Schatz, Pacific Science Center (www.dennisschatz.org © 1985 by Dennis Schatz)

Location and Timing

You can make a comet in a classroom, at a star party, with youth groups, and the general public. It can get a bit messy so it is good to have newspaper to put down if you are inside. The demonstration takes about 10-15 minutes.

Included in This Activity

Preparation Instructions
Detailed Activity Description
Helpful Hints
Background Information

Additional astronomy activities can be found here: http://nightsky.jpl.nasa.gov

Preparation Instructions

Collect all ingredients/materials in advance. It is strongly advised that you try the activity yourself first.

Detailed Activity Description

Activity Notes:
You can run this activity as a demonstration or as an activity where groups of participants get to make their own comet. Follow all safety guidelines below and make sure that your audience can follow directions or have adult supervision. See Helpful Hints at the end of the activity.

Instructions	Narrative
Step 1: Begin this activity by arranging all the ingredients and utensils in front of you on a sturdy worktable. You will need a helper who is wearing goggles and gloves. (If you will have each group make their own comet, see the Helpful Hints at the end of the activity.)	Everyone needs to be conscious about safety! We'll be using dry ice today. It can cause cold "burns" and flying chips can be damaging to eyes, so whoever handles the dry ice must always wear protective gloves and goggles.
Step 2: Open up one garbage bag and use it to line your mixing bowl. This will help you shape your comet, and make cleaning up easier at the end.	In our solar system, comets were part of what nature didn't clean up after the solar system was formed from a swirling disk of gas and dust called the solar nebula. As this nebula of gas and dust swirling around the sun cooled, it formed small rocks or planetesimals, which then gathered together to make bigger rocks, which ended up forming the planets and moons. Comets were the leftovers. You can think of them as the bits of dough left in the bowl when you make cookies.
Step 3: Add the 2 cups of water to the mixing bowl.	Comets have water in them. Water is made from just 2 elements – hydrogen and oxygen. The gases hydrogen and oxygen, as well as water vapor were probably all present in the solar nebula.

Step 4: Add 1/4-cup sand or dirt, stirring well.	You can't buy interplanetary dust at the store, so we have to use sand and dirt in its place. Sand and dirt have the minerals, and simple compounds that are found in comets. But dirt also contains bacteria, and mold, which are not found in comets. These living things have been created over the eons since the earth was formed.
Step 5: Next, add a dash of organic material (e.g. corn syrup or cola), stirring until well mixed.	Organic material means anything made up of carbon, hydrogen, nitrogen, and oxygen. Sugar, alcohol, and methane are all organic compounds. All living things are also made mostly of these four substances. Scientists have discovered that our Milky Way galaxy actually contains a very simple kind sugar that probably existed before the planets were formed! Corn syrup represents the simple organic compounds that were probably present in the solar nebula, and these helped form life later on.
Step 6: Add about 1/8 cup (2 Tablespoons) of ammonia and stir some more. You should have a muddy, slightly icky-smelling, sludge.	Ammonia, the same compound we use to clean windows, is another organic compound that existed in the solar nebula. The atmospheres of the giant planets Jupiter and Saturn contain large amounts of ammonia.
Step 7: Make sure your helper is wearing goggles and heavy gloves to handle the dry ice.	Dry ice is frozen carbon dioxide, the same gas that makes bubbles in soda pop. Most of the atmosphere of Mars is carbon dioxide. When a comet is far from the sun, its carbon dioxide is frozen into dry ice.
Step 8: (If your dry ice has already been crushed, read the narrative and go immediately on to Step 9.) Put the dry ice inside several plastic bags and crush it by pounding it with a hammer. You will need 2 cups of the crushed dry ice.	We crush the dry ice to make it mix with the water, dirt and organic material. All the "ingredients" in the original solar nebula were pretty evenly mixed, so our comet's ingredients should be well mixed with no really big lumps.

Step 9: .Have your helper scoop up 2 cups of the dry ice and add the dry ice to the other ingredients in the mixing bowl while stirring vigorously. Be sure to mix the ingredients quickly, for about 30 seconds. Move fast, as the dry ice will start to freeze the water right away.	Stirring is like the rotation of the solar nebula that "mixed" the original batch of comets as it whirled through space. Mixing also brings all the ingredients to the same temperature.
Step 10: Now take the spoon out and just let the comet sit for a minute or two.	Although most of our ingredients are at the same temperature as the surrounding air, the dry ice is about -79 degrees Celsius (or -110 degrees Fahrenheit). The dry ice cools the other ingredients until they are frozen solid. In space, real comets are usually so far away from the sun, they are even colder than this.
Step 11: Lift the comet out of the bowl by the plastic liner. Have one person hold the bag loosely. The person with the gloves should use their hands to compress and mold the contents for at least a minute. If you have more gloves, get others to help.	If the person holding the bag shuts it too tightly, the bag starts to blow up, or inflate. This is because some of the carbon dioxide is sublimating, or turning from dry ice into carbon dioxide gas. It's called "dry" ice because it never becomes a liquid. If a comet's orbit takes it near the sun and the sun heats it up, the surface of the comet starts to disintegrate and break down. Some comets go so near the sun that they completely fall apart and burn up.
Step 12: Unwrap your comet from the plastic bag, and you're done!	Don't worry if our comet doesn't look round and smooth. Real comets aren't either. Comets orbit the sun and have a variety of different orbital periods, ranging from a few years, to hundreds of thousands of years.
Step 13 *(optional)*: Place the comet in a glass bowl on an overhead projector that has been heating up for awhile. You can also use a heat lamp or very hot light bulb. See the Helpful Hints.	If a comet's orbit takes it near the Sun and the Sun heats it up, the surface of the comet begins to change directly from a solid into a gas and starts to form a long gossamer tail. As it heats up, and the ice that is holding it together disappears, it will shed some of its material leaving a trail of dust and small rocks in its wake. Some of these can contain ice.

Helpful Hints

If you would like to do this demonstration as an activity with many groups making their own comets, it is important that these groups are over the age of 9 and able to follow directions closely to reduce risk of injury. With school and youth groups, it is recommended that an adult supervise each group. You will need to supply the materials list for each comet. (One overhead projector or heat lamp is sufficient for the whole group.)

If you set up a heat lamp to demonstrate the how a comet's coma forms, point the lamp at the ceiling and hold a comet over it (with gloves on!) and you may see plumes of steam coming off. This steam is really water vapor that is condensed by the super-cold CO2 sublimating (changing directly from a sold to a gas) from the surface.

The disappearance of the comet might raise questions about what happens to real comets. You then have a chance to discuss how comets get close to the sun, how they are heated and "shed" material as they get close to the Sun in the form of gas, dust, and meteoroids, and thus gradually disintegrate.

Clean Up: The comets themselves can be placed in a large container like a detergent bucket. Students should not touch the comets with bare hands except very briefly. After they have melted again, dispose of the sludge in a well-lined garbage can or a toilet.

Background Information

Comets have a variety of different orbital periods, ranging from a few years, to hundreds of thousands of years, while some are believed to pass through the inner Solar System only once before being thrown out into interstellar space. Short-period comets are thought to originate in the Kuiper Belt, or associated scattered disc, which lie beyond the orbit of Neptune. Long-period comets are believed to originate at a very much greater distance from the Sun, in a cloud (the Oort cloud) consisting of debris left over from the condensation of the solar nebula. Comets are thrown from these outer reaches of the Solar System inwards towards the Sun by gravitational perturbations from the outer planets (in the case of Kuiper Belt objects) or nearby stars (in the case of Oort Cloud objects), or as a result of collisions.

An astronomer named Fred Whipple suggested in 1950 that comets were a lot like "dirty snowballs." He was right--they are mostly frozen water, with some other gases and dirty stuff. Comets spend most of their time as frozen globs traveling far away from the sun on huge orbits, that may or may not go near the sun. However we also know that a few times each century, we see one in sky, often with long fiery tails. You might want to discuss what your audience thinks causes these drastic changes.

This activity is adapted from a classroom activity, for use in schools and with further explorations. Learn more here:
http://cse.ssl.berkeley.edu/SegwayEd/lessons/cometstale/com.html

The bits of comets that fall off when they get close to the Sun are what often cause meteor showers here on Earth. When that happens, we are passing through the trail where a comet once passed. You can find out which comets produce some of the annual meteor showers here:
http://ssd.jpl.nasa.gov/?meteor_streams

For some great activities to use with younger audiences, see NASA's Solar System Exploration site. It also talks about how the tail of a comet always points away from the Sun:
http://solarsystem.nasa.gov/planets/profile.cfm?Object=Comets&Display=Kids

To learn about how NASA's LCROSS mission is investigating water that may have been left on the Moon from comet impacts, see their website:
http://lcross.arc.nasa.gov/

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The Night Sky Network is a nationwide coalition of amateur astronomy clubs bringing the science, technology, and inspiration of NASA's missions to the general public.

We share our time and telescopes to provide you with unique astronomy experiences at science museums, observatories, classrooms, and under the real night sky.
http://nightsky.jpl.nasa.gov

The International Year of Astronomy (http://astronomy2009.us) aims to help citizens of the world rediscover their place in the Universe through the daytime and nighttime sky. Learn more about NASA's contributions to the International Year of Astronomy at http://astronomy2009.nasa.gov